Vehicle Innovation Day: Military use of AV and CV

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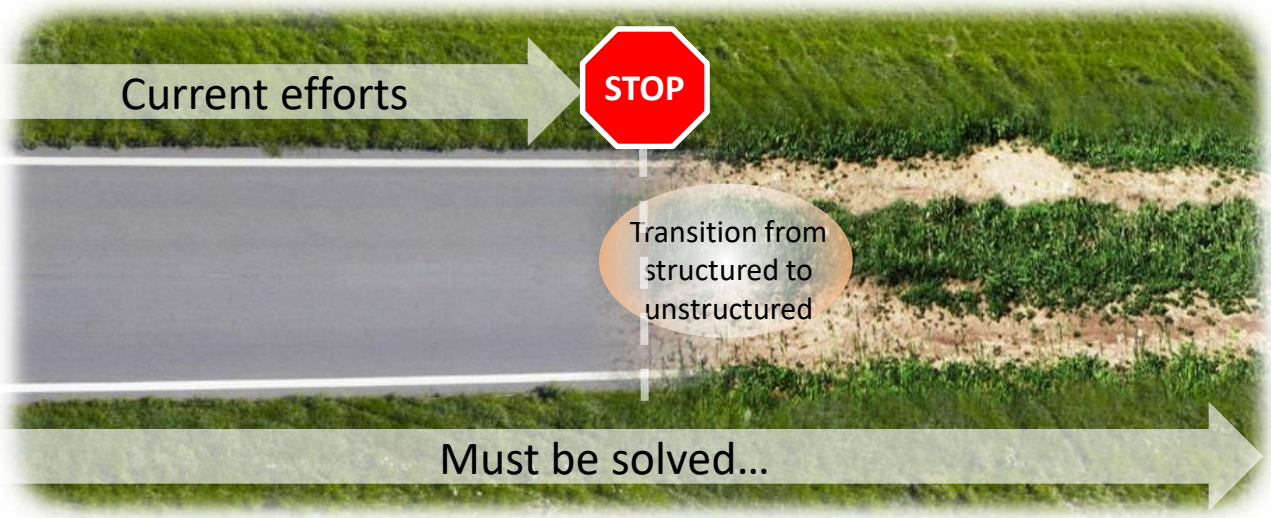
Why is the Military (off-road) Perspective Important?

Problem: How Do You "Finish" The Drive…



- Efforts at Automated Driving have focused on:
  - Paved roads
  - Pavement markings / traffic control devices
- To finish the drive in many places you need:
  - Ability to navigate roads that are not paved or mapped (63% of world wide roads paved, 65% in the US)
  - Environments with lots of vegetation and no stripes/signs

When AVs arrive at their destination…

- On average approximately 63% of the roadways in the world are paved:

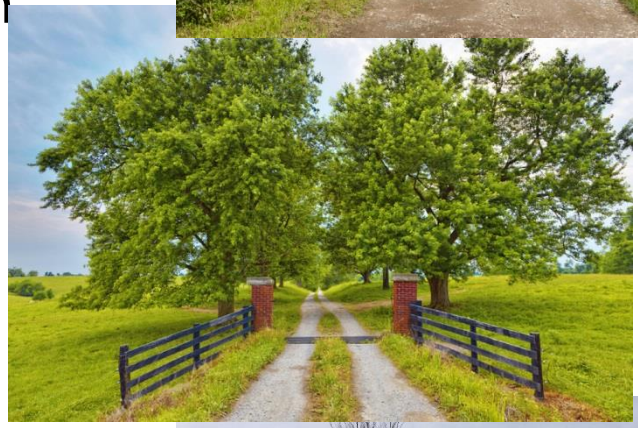
Selected Countries	Total Kilometers	Paved Kms	Unpaved Kms	Percent Paved
Brazil	1,580,964	212,798	1,368,166	13.5%
Canada	1,042,300	415,600	626,700	39.9%
China	4,106,387	3,453,890	652,497	84.1%
Indonesia	496,607	283,102	213,505	57.0%
Japan	1,217,128	988,536	228,592	81.2%
Mexico	377,660	137,544	240,116	36.4%
Russia	1,283,387	927,721	355,666	72.3%
United States	6,586,610	4,304,715	2,281,895	65.4%
Worldwide Total:	46,771,989	29,364,673	17,407,316	62.8%

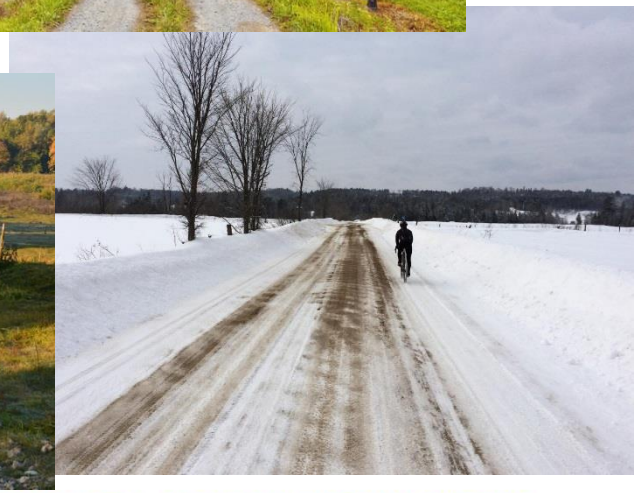
- What will happen when an AV needs to leave a highly structured road environment and deliver the riders to the "door"?
  - In the US this will happen very frequently

Rural Roads

- Very difficult to pre-drive and map
- Major objects change each season
- Road surface varies widely based on season and maintenance practices

Select States (kilometers)	Total	Paved	Unpaved	% Unpaved
Texas	512,656	357,499	155,157	30%
California	273,822	160,797	113,026	41%
Michigan	195,426	99,667	95,759	49%
Nebraska	154,802	82,499	72,303	47%
Alaska	25,088	4,857	20,231	81%
Total US:	**6,584,739**	**4,214,233**	**2,370,506**	**36%**

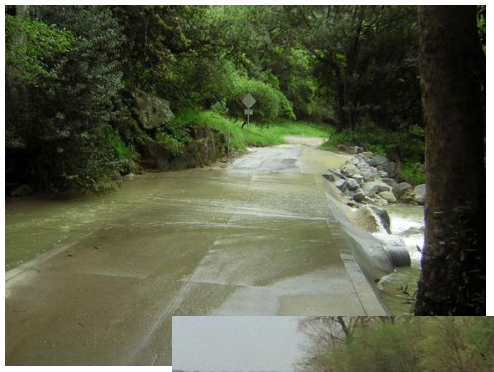
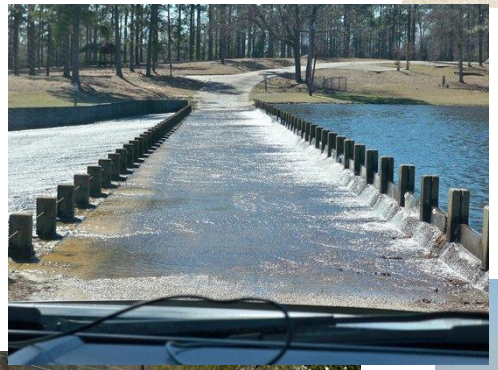




Unusual Road conditions

- Negative Obstacles
- Water with unknown consequences
- Short term construction detours that utilize alternative road materials and limited to no lane markings (use barrels / cones)





State of the Practice (agricultural/mining): John Deere / Komatsu

Source: Komatsu

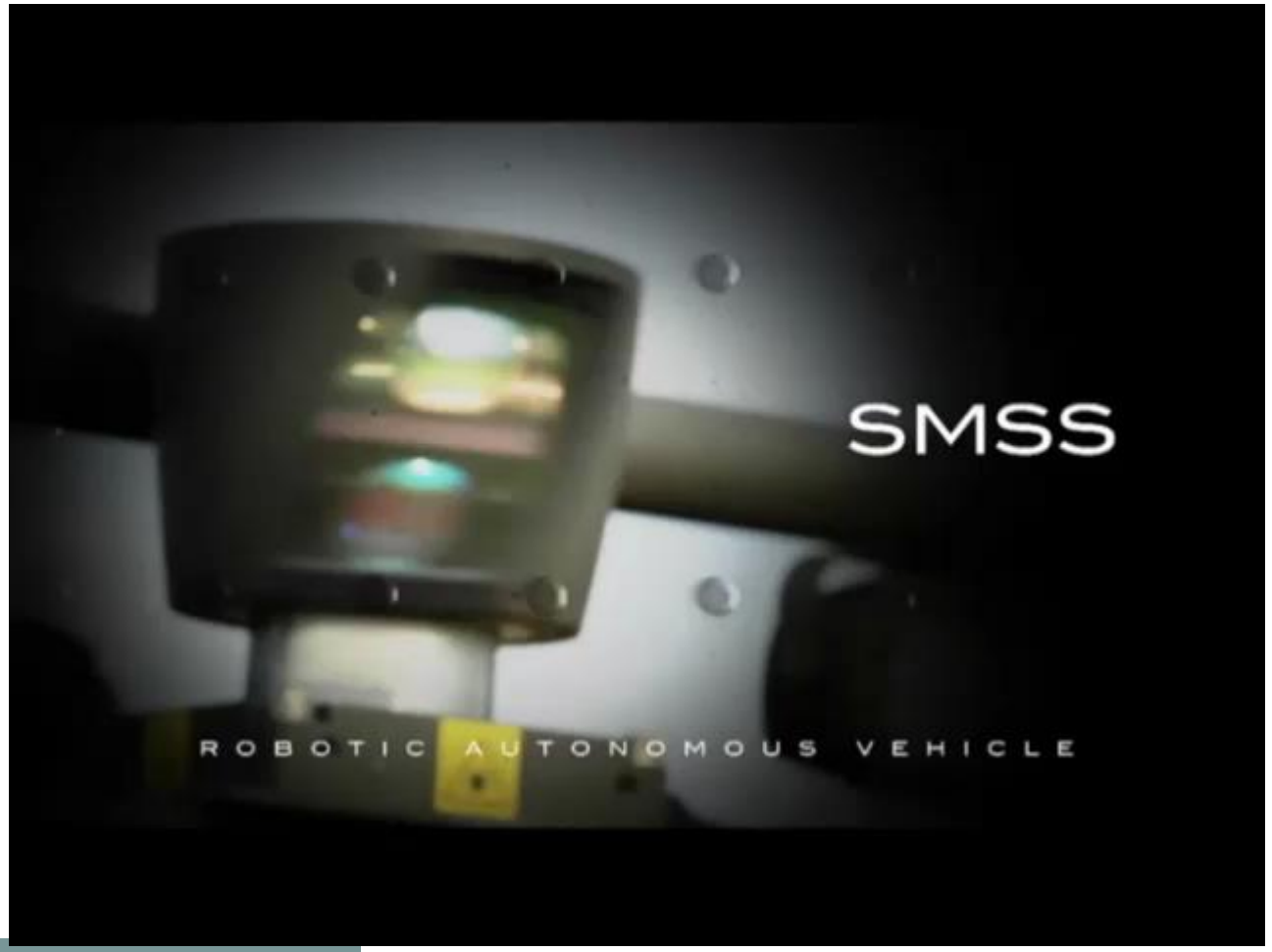
- Deere:
  - Agriculture
  - Constrained environment

Source: John Deere

- Komatsu
  - Fixed route
  - Very dirty conditions

State of the Practice (military):
(mules and support tools)

- Squad Mission Support System (SSMS)
  - Active sensor technology
  - Carry loads over difficult terrain



Source: Lockheed Martin

State of the Practice (military):
(small bots)

- Many variants developed
- Some variants deployed
- Challenges:
  - Maintenance issues
  - Proprietary nature of devices

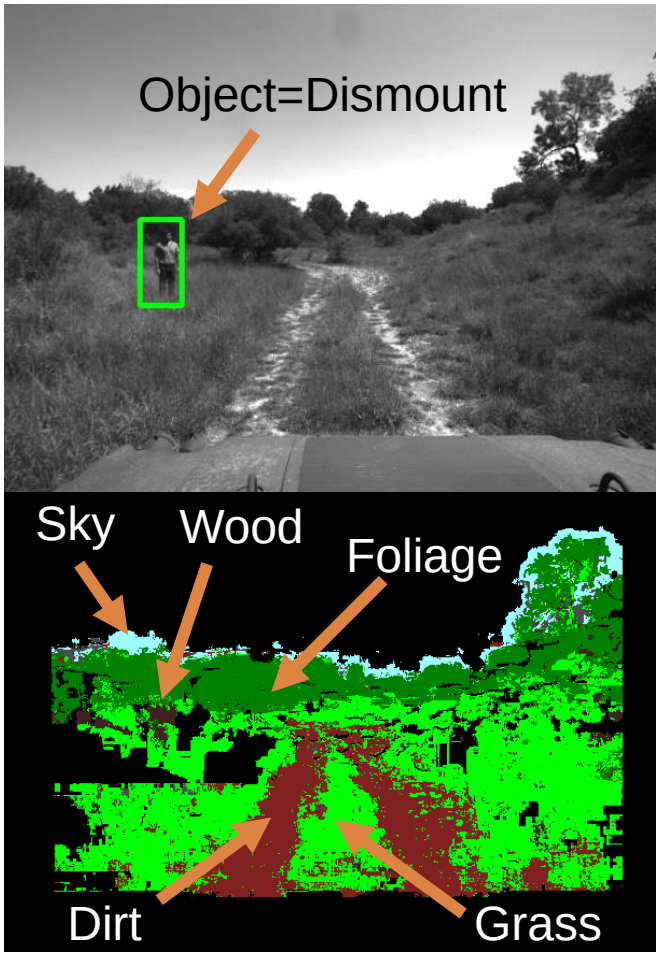
Source: iRobot

State of the Practice (military): AMAS (LM)

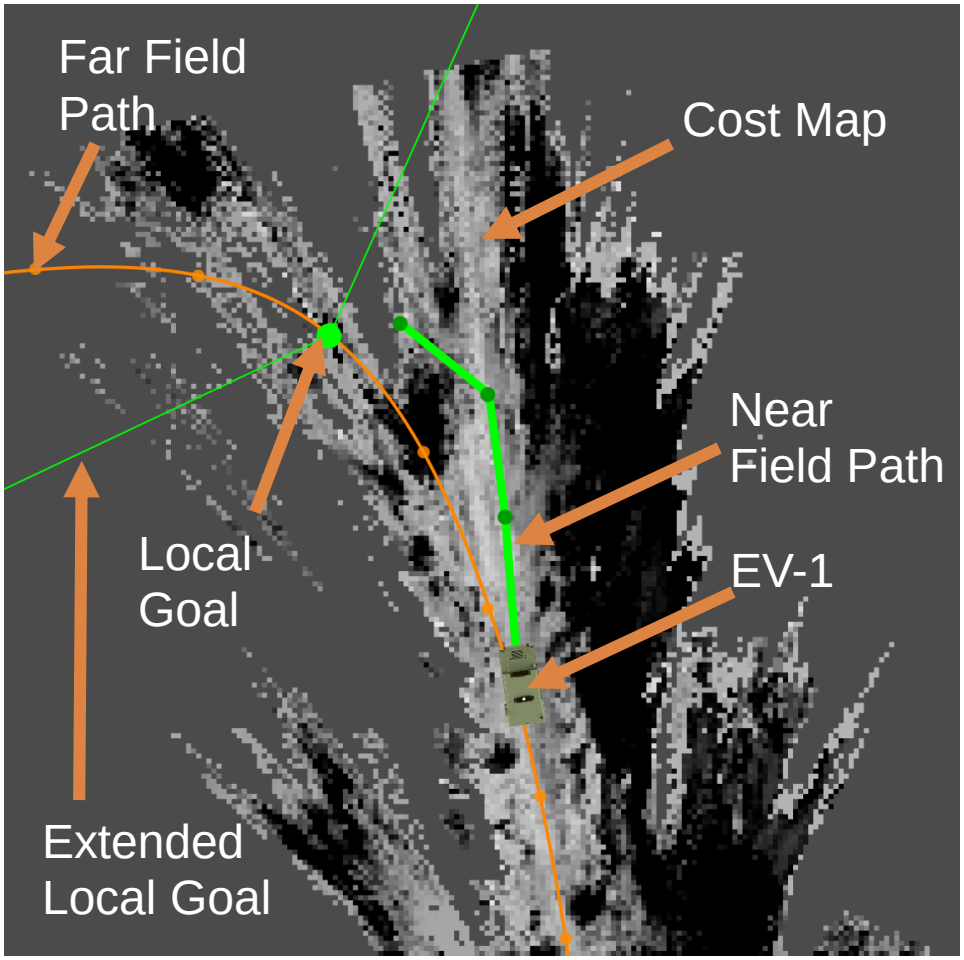
Introduced "A-Kit" (autonomy) and "B-Kit (by wire)

Source: Lockheed Martin

SUMET EO-Only Perception Introduced "passive sensors"



Material Classification



Cost Map and Path Planners

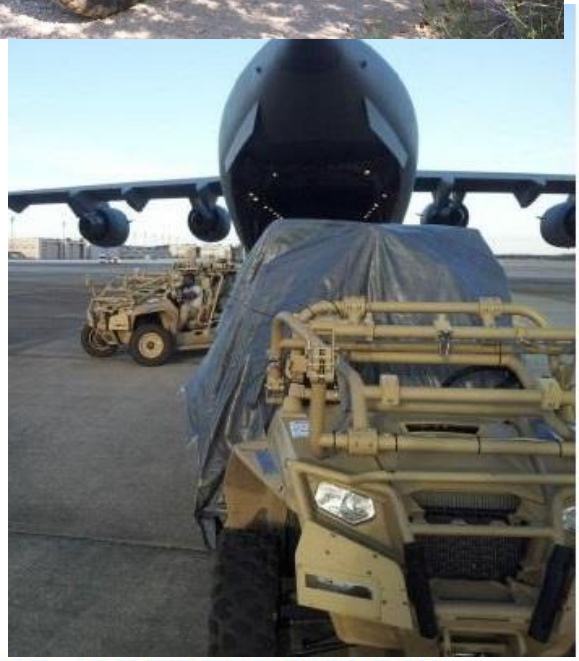
Marine Corps SUMET Program

Office of Naval Research – Code 30
Ground Vehicle Autonomy Program:
Small Unit Mobility Enhancement Technology (SUMET)

SUMET v2.0 Experimentation

SwRI – San Antonio, TX
29 November 2012

Army: DSAT (Dismounted Solider Autonomy Tools)
ATEC Tested and Deployed System



DSAT Capability Video

Lockheed Martin K-MAX

- Marine Corps program
- Capable of delivering a full 6,000 lb of cargo at sea level and more than 4,000 lb at an altitude of 15,000 feet.
- First mission in Afghanistan on December 17, 2011.
- Deployment ended 2014

Source: Lockheed Martin

Current Programs

RTK (Robotics Technology Kernel)

Provides: platform, non-proprietary AV

AGR (Autonomous Ground Supply)

Manned Leader, automated follower(s)

Current Programs – con't

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Wingman

Tracked Vehicle Autonomy
(program in the initial stages)

Questions?

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